CLAIMS

1. A manufacturing method of a semiconductor device, comprising the steps of:

depositing on a substrate a dielectric film made of fluorine-added carbon;

forming on the dielectric film a protective layer comprising a nitrogen-added silicon carbide film; and

depositing on the protective layer a thin film serving as a hardmask made of oxygen-added silicon carbide by a plasma containing active species of silicon, carbon, and oxygen.

2. The manufacturing method according to claim 1, wherein

the plasma containing active species of silicon, carbon, and oxygen is a plasma obtained by activating a gas of an organic silicon compound and an oxygen gas.

3. The manufacturing method according to claim 1, wherein

the step of forming the protective layer includes the sub-steps of:

depositing on the dielectric film a silicon carbide film by a plasma containing active species of silicon and carbon; and

depositing on the silicon carbide film a nitrogen-added silicon carbide film by a plasma containing active species of silicon, carbon, and nitrogen.

4. The manufacturing method according to claim 1, wherein

the step of forming the protective layer includes the sub-steps of:

depositing on the dielectric film a silicon carbide film by a plasma obtained by activating a gas of an organic silicon compound; and

depositing on the silicon carbide film a nitrogen-added silicon carbide film by a plasma containing active species of an organic silicon compound and active species of nitrogen.

5. The manufacturing method according to claim 1, further comprising the steps of:

forming on the thin film serving as a hardmask a resist film having a specific pattern;

etching the thin film by a plasma through the resist film to obtain a hardmask having a pattern corresponding to that of the resist film; and

etching the dielectric film by a plasma through the hardmask.

6. A manufacturing method of a semiconductor device, comprising the steps of:

depositing on a substrate a dielectric film made of fluorine-added carbon;

depositing on the dielectric film a silicon carbide film by a plasma containing active species of silicon and carbon; and

depositing on the silicon carbide film a thin film serving as a hardmask made of nitrogen-added silicon carbide by a plasma containing active species of silicon, carbon, and nitrogen.

7. The manufacturing method according to claim 6, wherein

the plasma containing active species of silicon and carbon is a plasma obtained by activating a gas of an organic silicon compound.

8. The manufacturing method according to claim 6, wherein

the plasma containing active species of silicon, carbon, and nitrogen is a plasma obtained by activating a gas of an organic silicon compound and a nitrogen gas.

9. A film deposition system comprising:

a first processing vessel that receives a substrate;

first means that generates in the first processing vessel a first plasma containing active species of carbon and fluorine;

a second processing vessel that receives the substrate;

second means that forms in the second processing vessel an atmosphere for depositing a nitrogen-added silicon carbide film;

a third processing vessel that receives the substrate;

third means that generates in the third processing vessel a second plasma containing active species of silicon, carbon, and oxygen; and

a controller that controls the first, second, and third means to execute the steps of:

(a) generating in the first processing vessel the first plasma by the first means to deposit on the substrate a dielectric film made of fluorine-added carbon;

(b) forming in the second processing vessel the atmosphere by the second means to deposit on the dielectric film a protective layer comprising a nitrogen-added silicon carbide film; and

(c) generating in the third processing vessel the second plasma by the third means to deposit on the protective layer a thin film serving as a hardmask made of oxygen-added silicon carbide.

10. The film deposition system according to claim 9, wherein

a single processing vessel is used as at least two of the first, second, and third processing vessels.

11. A film deposition system comprising:

a first processing vessel that receives a substrate;

first means that generates in the first processing vessel a first plasma containing active species of carbon and fluorine;

a second processing vessel that receives the substrate;

a first gas supply system that supplies into the second processing vessel a first process gas containing silicon and carbon, while controlling a flow rate of the gas;

a second gas supply system that supplies into the second processing vessel a second process gas containing nitrogen, while controlling a flow rate of the gas;

second means that converts the first and second process gasses supplied into the second processing vessel into a plasma; and

a controller that controls the first and second means, and the first and second gas supply systems to execute the steps of:

(a) generating in the first processing vessel the first plasma by the first means to deposit on the substrate a dielectric film made of fluorine-added carbon;

(b) converting in the second processing vessel the first process gas supplied by the first gas supply system into a plasma by the second means to deposit on the dielectric film a silicon carbide film; and

(c) converting in the second processing vessel the first and second process gases supplied by the first and second gas supply systems into a plasma by the second means to deposit on the silicon carbide film a thin film serving as a hardmask made of nitrogen-added silicon carbide.

12. The film deposition system according to claim 11, wherein

a single processing vessel is used as the first and second processing vessels.